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**METHOD FOR PERMITTING DEBUGGING AND TESTING OF SOFTWARE ON
A MOBILE COMMUNICATION DEVICE IN A SECURE ENVIRONMENT**

Technical Field

This invention relates in general to software authentication for mobile communication devices, and more particularly to debugging and testing software application code in a secure environment.

Background of the Invention

Mobile communication devices are in widespread use, particularly in metropolitan areas. Traditionally these devices have been used for voice communication, but as computing power becomes more affordable, these devices are evolving. Already there are mobile communication devices that are capable of browsing information on the Internet with a "microbrowser". Content providers and web site operators are providing content specifically for these devices in a format that is readable by the microbrowser. Furthermore, microbrowsers are becoming more sophisticated, and are capable of executing portable code, such as JAVA applets. As a result, parties other than the manufacturer of the mobile communication device have the ability to develop software to be executed by the mobile communication device.

This presents a few problems.

As with more conventional desktop or personal computer platforms, the mobile communication device is susceptible to poorly designed code, or worse, code designed to accomplish some malicious purpose. To prevent problems associated with such code, a security scheme has been adopted similar to that used by personal computers.

- 5 The mobile communication device is provided with a root key, which may be, for example, the public key of a trusted authority which is part of a public key infrastructure. There are companies which specialize in this service, and perform verification services so that a developer can distribute their software in a manner in which those who download the software can be assured that the code is authentic, and
- 10 has not been altered. It would be preferable to have this security feature active all the time, this has presented a problem with developers because they frequently test many versions of the code during development, and having to obtain certificates for each incremental version impedes the efficiency of the development process.

- Presently there are two conventional solutions to this problem. One is the use of
- 15 a mobile communication device with a special software load for developers in which the security has been disabled. This is undesirable because the device is then not representative of an actual users device. It is preferable to have an environment representative of the target device to facilitate debugging and development. Another conventional solution is to allow the security to be disabled. This might require a
- 20 special sequence of buttons to enable or disable. However, this gives the ability of anyone who knows how the ability to disable the security. Since mobile communication devices use a shared resource, a flawed or maliciously designed software application could affect many other users. Therefore there is a need for a security scheme that is always active, yet allows flexibility for developers without unduly hindering
- 25 development efforts.

Brief Description of The Drawings

FIG. 1 shows a block diagram of a wireless communication system interfaced with the Internet, in accordance with the invention;

5 FIG. 2 shows a block diagram of a mobile communication device and associated software security architecture; and

FIG. 3 shows a sequence chart for downloading an application signed with a debug certificate, in accordance with the invention.

Detailed Description of a Preferred Embodiment

10 While the specification concludes with claims defining the features of the invention that are regarded as novel, it is believed that the invention will be better understood from a consideration of the following description in conjunction with the drawing figures, in which like reference numerals are carried forward. A brief description of the prior art is also thought to be useful.

15 The invention solves the problem of testing and debugging code in a mobile communication device working on a live system and having a secure environment by eliminating the need to generate a new certificate with every version or build of code to be tested. Instead, the present invention provides a way of generating a multi-use certificate that a code developer can use to sign different versions or builds of code, and have them properly authenticated, without generating a new certificate for each new
20 version or build of code to be tested. The present invention accomplishes this by use of a new class of certificate referred to as a development certificate. The development certificate specifies the machine it is to be used with, such as by specifying the international mobile equipment identifier of a mobile communication device, for example, and specifying a development parameter. The development parameter can
25 specify the time period of use, the number of uses, and so on. Using the newly developed type of certificate, a developer can specify the particular mobile communication device on which the code is to be tested, obtain a development

certificate from a public key infrastructure provider such as a certificate authority, and test several versions of the code being developed, on a live system, with device which has the same security environment as one sold into retail channels.

Referring now to FIG. 1, there is shown therein a block diagram 100 of a wireless communication system connected to the Internet, in accordance with the invention. A software developer's office 102, of a developer which desires to develop a software application or other code for use in a mobile communication device 104, includes the mobile communication device 104, a server 106 and preferably a local computer 108. The mobile communication device 104, is, for example, a mobile radio telephone or a cellular telephone, and communicates with mobile or wireless infrastructure equipment 110. The mobile communication device contains certain computer resources such as scratch pad memory (random access), non-volatile storage, operating system software, other application processing code, means for transmitting and receiving radio signals, power source means, user interface and ergonomic software layers, and display means and keypad means for displaying and entering information, respectively, among other computer resources. In the non-volatile memory there is stored a device identifier, such as an international mobile equipment identifier (IMEI) as is well known in the art, and a root key for authenticating code developed by third parties. The mobile communication device further comprises wireless network interface means, such as that used to establish and maintain packet data communication, and content browsing means such as a microbrowser for browsing content on the Internet. With the browsing means there is included a security means, in software, for preventing unauthorized access to protected computing resources, such as, for example, a Java or virtual machine software execution environment.

The wireless infrastructure 110 includes a base station 112, and typically a plurality of such base stations, for establishing serving cells within the vicinity of each such base station, as is well known in the art. Each such base station is operatively

coupled to a mobile switching center (MSC) 114, and other switching equipment included therein. The MSC facilitates telephone interconnect calling and is operatively coupled to a public switched telephone network (PSTN) 115. The MSC or related equipment is also operatively coupled to a wide area public network, such as the Internet 116. Typically the link between the mobile infrastructure equipment and the wide area public network is a standard transport link, and uses, for example, TCP/IP, as is common, and uses a gateway located at the MSC, as is known in the art. Various equivalent arrangements exist for coupling the wireless infrastructure to networks to facilitate use of those networks by the mobile communication device.

To facilitate security operations in the mobile communication device 104, a public key infrastructure service provider has a machine or server 118 operatively coupled to the Internet, and is such that other machines operatively coupled to the Internet can transact with the server 118. Generally, such service providers provide encryption technologies such as public keys and authentication services including digital encryption certificates and code signing services for use by software and code developers. Such products and services are used by target devices to verify the authenticity of software and code obtained over public networks. These services are presently in widespread use, and provided by companies such as Verisign, Inc., which can be found on the Internet with the uniform resource locator (URL) of www.verisign.com. Preferably, included at the public key infrastructure service provider is a certificate authority server 120 and a code signing server 122. These are also transactable with other machines over the public network.

A secure time server 124 is also provided, and operatively coupled to the public network. Other machines transact with the secure time server to obtain authentic time stamps or readings, or both. In other words, when a machine coupled to the public network needs to verify the present time, it sends a request to the secure time server for the present time, which may include the present date. The time server then responds by

sending an encrypted time reading back to the requesting machine. The requesting machine then decrypts the time reading using a public key of the time server, which has been previously provided to the requesting machine. In some instances the secure time server may be included with, and operated by the public key infrastructure service provider, and coupled to the server 118. In which case the public key for the time server could be the same as that of the public key infrastructure service provider. Such time servers are known in the art.

FIG. 2 shows a block diagram of a mobile communication device's associated software security architecture 200. The mobile communication device under consideration here is one used by a code developer to test and debug software and code developed by the developer. A software or code package 202 is obtained by the mobile communication device, and is meant to be installed in the mobile communication device. The software package includes the executable code 204, a descriptor file 206, and a development certificate 208. The development certificate, in accordance with the invention, comprises a device identifier of the particular mobile communication device, which is unique to the particular mobile communication device, and a development parameter. The development parameter is a parameter chosen by the developer to indicate under what conditions the development certificate is valid. For example, the development parameter may be a limited period of time, a preselected number of instantiations of the code to be tested, the number of versions which may be tested under the development certificate, and so on. It is also specifically contemplated that the development parameter may include a download counter or counter value to control the number of times the software application may be downloaded and installed into the machine. In the course of development, several slightly different versions may be tested. The development certificate is created in accordance with the method of the invention described hereinbelow. The mobile communication device comprises a software execution environment 210, including a security manager, a security domain,

and resources 216 including physical, software, and data resources. The security manager is a software layer that assigns permissions to code that is installed into the mobile communication device, and either allows or denies use of resources by code that is installed. If a code segment or application does not have appropriate certification, the security manager denies use of all resources to prevent corruption of the resources or code being executed. The security domain is the set of resources which a particular code segment or application is allowed to access. The security domain may therefore be different for different applications, depending on which resources the application needs access to, and whether or not the application is properly authenticated with, for example, public key cryptography. The security domain necessary to properly execute the application is provided in the software code package 202 in a security policy described in the descriptor file 206. Once the software package is authenticated, the security manager can set the permissions appropriately, in accordance with the security policy

The software package 202 of FIG. 2 is generated, loaded, authenticated, and installed as described in FIG. 3, which shows a sequence chart 300 for downloading an application signed with a debug certificate, in accordance with the invention. The four main entities involved are the developer 302, a public key infrastructure (PKI) server 304, the mobile communication device 306, and optionally a time server 308. The procedures described herein include both a method for testing software on a portable device, and a method for permitting debugging and testing of software on a mobile communication device.

The process starts at the developer 302, who generates code (310) that needs to be tested and or debugged. The code is typically developed on a general purpose computer or workstation, such as that indicated in FIG. 1 as a local computer 108. When the developer is ready to load the code, which may be an application or some other software entity, the developer sends or otherwise transmits a request (312) for a

development certificate to the PKI server 304. The PKI server is operated and controlled by a public certificate authority. The request includes a device identifier which is a unique identifier of the particular portable device or mobile communication device on which the code will be loaded and tested, and a developer's identifier to
5 permit authentication of the developer. The request also includes a development parameter and the developers digital identification. The development parameter is included to limit the validity of the development certificate. The PKI server authenticates the request (314) by, for example, authenticating the digital signature of the developer. Upon successfully authenticating the developer's request, the PKI server
10 creates the development certificate. The development certificate includes the device identifier and the development parameter. These data entities are made secure with appropriate cryptographic techniques such as one way hashes, for example.

Once the development certificate is generated, the public certificate authority's PKI server sends or transmits it back to the developer, who receives it at their office
15 (318). The developer then signs the code or software application to be tested with the development certificate (320), thereby providing a signed software application. Typically the software will be in an archive format, such as a Java archive, or JAR file, with the application itself being in byte code for portability among platforms. The signed software application is then loaded onto a server (322), such as the developer's
20 server 106 of FIG. 1. At this point the mobile communication device is ready to load the software. This can be done in by one of two ways, either use if a cable between the computer on which the signed software application resides, or over the air. Loading the signed software application (324) can be initiated by either the target mobile communication device, or by the developer if desired. Once the mobile communication
25 device receives the signed software application, it decrypts the certificate (326) and commences authenticating the developer's signature (328, 330), including verifying the device identifier. If the device identifier does not match the device identifier of the

mobile communication device, the software package may be discarded. The authentication is done over the air interface using a network connection and the gateway for the wireless system infrastructure 110. If the development parameter specifies a time period of validity, the mobile communication device can then the

5 mobile communication device requests a signed time reading (332) from a trusted time server, which sends back a (334) signed or stamped time reading. The mobile communication device then verifies the time reading (336). The mobile communication device also creates and stores a hash of the development parameter (338) for use with subsequently loaded versions of the software. This hash is stored in non volatile

10 memory. The security permissions are then set according to the descriptor file 206, and the application can then be installed. The development parameter used is a number of times the code may be executed, each time the code is called, it will increment a count of the number of times it has been called, keep this count in a cryptographically secure format in the mobile communication device's non-volatile memory, and check it each

15 time the software is called to determine if the software can still be used. The same is true for other development parameters that may be used such as validity period, for example. Each time the software is called, the development parameters are checked against the present condition of those parameters to determine if the development certificate is still valid. If not, then execution of the software is immediately aborted.

20 Therefore, execution of the software commences only if the device identifier of the development certificate matches the device identifier of the portable device or mobile communication device, and the development parameter is likewise valid. The invention further embodies a method of generating a development certificate for use in testing a software application in a mobile communication device. The method

25 comprises receiving, at a public certificate authority, request from a developer for a development certificate. The request will include a device identifier and a development parameter, and is signed with, for example, the public key of the developer. The public

certificate authority then generates the development certificate, and includes the device identifier and development parameter.

Thus, the problem of the developer having to request a certificate for each incremental version of a software entity, for testing and/or debugging, is obviated by use of the development certificate which is reusable for as many versions as the developer wants, for a period of time, or for a predetermined number of instantiations of the code in the executable environment of the portable device or mobile communication device, or a combination of several such parameters. The developer can reuse the same development certificate for different versions of the software to be tested, and it will be installed and executed by the target device so long as the device identifier and development parameter are valid. This facilitates rapid development while maintaining the security measures of the software environment in the portable device. The process makes use of a development parameter or parameters, in conjunction with specifying a unique identifier of the portable device, and cryptographic techniques used for authentication and monitoring the usage of the software by the portable device. The portable device itself maintains certain variables to keep track of the use and instantiations of the software, when needed, to determine whether or not further execution is permitted. While the preferred embodiments of the invention have been illustrated and described, it will be clear that the invention is not so limited. Numerous modifications, changes, variations, substitutions and equivalents will occur to those skilled in the art without departing from the spirit and scope of the present invention as defined by the appended claims.

What is claimed is: